

## **ADWR Memorandum**

**To: ADWR Phoenix AMA Modeling File**

**From: Keith Nelson, Justin Ferris, Clint Wyatt, ADWR – Hydrology**

**Date: 5/5/15**

**Subject: Santa Cruz Active Management Area Workshop**

### **Introduction**

The City of Nogales hosted a two-day workshop sponsored by the Arizona Department of Water Resources. The purpose of the workshop was to bring together professionals, stakeholders, citizens, and other interested parties of the Santa Cruz AMA (SCAMA), provide a general overview of the state of the Upper Santa Cruz River, and present the latest technical information pertaining to Santa Cruz River hydrology, environmental quality, and geology. . The first day of the workshop included presentations by speakers representing the United States Geological Survey (USGS), Arizona Department of Environmental Quality (ADEQ), Arizona Department of Water Resources (ADWR), City of Nogales (Nogales), and the Hydrologic Research Center (HRC) in San Diego. The second day was spent in the field visiting ADWR index wells, various locales along the Santa Cruz River, and relevant geologic outcrops. This memo will document in detail both days of the workshop.

### **Day 1 – Technical Presentations**

The meeting was held at the Nogales Public Works building in Nogales, AZ on April 22-23, 2015. The first day of the workshop was dedicated to technical presentations about Upper Santa Cruz River hydrology, environmental quality, and geology. There were approximately 25 attendees for the first day of the workshop, including the speakers, representatives from non-presenting groups like the United States Bureau of Reclamation, the State of Arizona, and local

citizens and landholders. A brief report, modeled on the day's agenda with estimated times, follows.



Nogales Public Works building in Nogales, AZ (from <http://www.nogalesaz.gov/>)

0900: Jeff Tannler, ADWR, opened the first day of the workshop with a brief overview of the SCAMA, its water management, and hydrologic context. This included the 1980 Groundwater Management Act, the establishment of the AMA in 1994, and the AMA's unique two-goal management plan of maintaining a safe-yield condition in the active management area and preventing local water tables from experiencing long term declines. This was followed by a brief explanation of water use in the SCAMA by Alejandro Barcenas, Public Works Director for Nogales. This use includes pumping from two Nogales well-fields located along the Upper Santa Cruz River and the Potrero area west of the river.

0915: Keith Nelson, ADWR, then gave a presentation on the hydrology and groundwater modeling of the Santa Cruz River. This included an overview of the river's hydrology in both the micro-basins and the northern SCAMA regions, the importance of flood-flow recharge to the

river, and the hydraulic properties of the aquifers. Keith then briefly outlined the development and current state of the SCAMA's two groundwater flow models currently undergoing an update, calibration, and sensitivity analysis.

1100: Hans Huth, ADEQ, gave a presentation on water quality issues associated with the Nogales Wash. Similar to the Santa Cruz River to the east, the Nogales Wash flows into Arizona from Sonora, and is thus influenced by the hydrology of both the United States and Mexico. During the monsoon, the wash is impacted by sanitary sewer overflows (SSOs) originating from Sonora. Sewage may contain contaminants associated with metal plating and other industrial operations south of the border. Hans detailed how these activities have a detrimental impact on the water quality of the wash, and shared ongoing activities focused on mitigating these deleterious effects.

1145: Ric Page, USGS, presented a general overview of the geology of the Nogales and Rio Rico quadrangles being concurrently developed by the USGS. These maps detail surficial exposures of the geologic units relevant to most of the Upper Santa Cruz River, Potrero Area, and Nogales Wash area, including the younger alluvial deposits along the river, the older alluvial deposits exposed to the east of the river and west of the wash, and the various members (Mariposa, Nogales Wash, and Proto-Canyon) of the Nogales formation that are exposed between the river and wash along Mount Benedict as well as north of their confluence. He also included stratigraphic cross-sections and Earth Vision 3-D models of the area. An important detail of the geology is the fracture networks in many parts of the formation, which may control the local hydrogeology. These fracture networks formed during episodes of Miocene extensional deformation, which was contemporaneous with deposition of Nogales Formation sediments.

1230: Mark Bultman, USGS, followed Ric Page's talk with a detailed explanation of the bedrock structure of the Nogales and Rio Rico quadrangles and technical demonstration of the geophysical modeling being used by the USGS. These methods include the use of electrical resistivity, aeromagnetic surveys, and gravity surveys to better understand the sub-surficial geology of Nogales and Rio Rico quadrangle areas. Mark also presented detailed composites of these several data sets to produce a hybrid plan-view and cross-section map of the area to demonstrate the geology of the area in 3-D space.

1330: Lunch was provided by the City of Nogales.

1400: James Callegary, USGS, continued Ric and Mark's themes with a presentation on the geology of the Patagonia Mountains and the Sonoita Creek Watershed. In his talk, James described the current geologic understanding of the Patagonia Mountains and their relationship and controls on the Sonoita Creek to the north. Sonoita Creek has its confluence with the Santa Cruz River north of the Santa Cruz – Nogales Wash confluence and south of Rio Rico. This provides an important hydraulic constraint on the river, impacting river hydrology downstream as well as providing an important source of input for the SCAMA North groundwater flow model.

1445: Clint Wyatt, ADWR, gave a talk on the current state of the SCAMA micro-basins groundwater model. This model was originally published in 2007 (ADWR Report No. 15) and simulated the period 1997-2002. Clint's update includes the addition of new well and streamflow data to the end of the calendar year 2013. In addition to a general data update, the model is currently undergoing automated calibration and sensitivity analysis, something that the previous model iteration did not include. These methods will optimize the groundwater model and make it suitable for future use in ADWR water planning strategies.

1515: Justin Ferris, ADWR, followed Clint's talk with a presentation on the current state of the SCAMA north groundwater model. This model was originally published in 2007 (ADWR Report No. 14) and simulated the period 1997-2002. Justin's update include the addition of new well and streamflow data to the end of water year 2013, as well as update discharge information from the Nogales International Wastewater Treatment Plant (NIWTP). Justin outlined the work he has done on the river simulation within the model and the current state of the automated calibration and sensitivity analysis. ADWR plans to join the SCAMA micro-basins and SCAMA North models into a composite model that also includes the Potrero Well field Area and the Nogales Wash.

1600: Eylon Shamir, HRC, closed the day's talks with a presentation on his work at the HRC relating to stochastic streamflow modeling of the micro-basins area. This work is part of the University of Arizona's Groundwater, Climate, and Stakeholder Engagement (GCASE) program and includes a hydrologic model of the area as well as development of a climate change component that, together, are used to simulate future changes and impacts to the study area. Eylon has also collaborated with the ADWR and Santa Cruz AMA Groundwater Users Advisory Council (GUAC). Eylon's work shows that it is likely that future winters and summers will have less frequent but more extreme episodes of rainfall and flood flow to the river. Considering the impact that the river has on the SCAMA, this has important implication for water management with the AMA.

## **Day 2 – Field Trip**

The second day of the workshop was spent in the field visiting locations relevant to the previous day's subjects as well as additional locations of interest. The first half of the day was

dedicated to the local geology and was led by Ric Page and Mark Bultman of the USGS, while the second half of the day was dedicated to visiting ADWR index wells and was led by Mark Perez and Nick Valverde of ADWR's Basic Data group. A brief description of the stops with pictures (courtesy of Jeff Tannler and Justin Ferris) follows. For stops, see map in Appendix.

Stop 1 was the Meadow Hills area, which includes the Las Lagunas de Anza (recently designated an official certified site of the Juan Batista de Anza National Historic Trail by the National Park Service), a City of Nogales well (Meadow Hills 2, currently offline), and an ADWR index (transducer) well, D-23-13 36BDD. This location is unique because of the wetlands, which are fed from groundwater discharge at the surface in the Potrero Creek watershed area and provide a unique environment for local wildlife. It also has an impact on the nearby Meadow Hills subdivision. The city well is currently offline and has been for over a year. The ADWR index well is relatively close and includes a transducer that records water levels several times a day. ADWR hopes to conduct stress tests to better understand the hydraulic connection, or lack of, between the wetlands and aquifer.



Stop 1: Lee Jacobs (City of Nogales, left) and Keith Nelson (ADWR, right) with the Las Lagunas de Anza wetlands in the background.

Stop 2 was just up the road from the wetlands and was of an outcrop of older alluvium, described by the USGS as Quaternary to Tertiary aged river alluvium, comprising a mixed assemblage of semi-consolidated sands and gravels. This deposit is simulated as layer 2 in both the SCAMA micro-basins and SCAMA north groundwater models and is important for its hydrogeological controls on subsurface flow within the SCAMA. It is exposed in the micro-basins area east of the river and in the Potrero area west of the Nogales Wash. It is exposed in the SCAMA north area on either side of the river outside of the younger alluvial deposits.





Stop 2: Older alluvium outcrop with Mark Bultman (USGS) in the foreground.

Stop 3 comprised multiple points of interest, including a good view of the city. Mark Bultman and Ric Page first gave a description of the area from their in-progress USGS map, which is an update to previous iterations of USGS geologic maps. Next, the group took a walk along a paved trail to view a fault contact between two members of the Nogales formation; here, the Proto-Canyon (older) and Mariposa (younger) members were juxtaposed against one another, providing evidence of faulting. Past this fault, we walked to a view that overlooked Interstate 19 where we viewed fractured outcrops of the Mariposa Member. The Nogales Wash Member (middle) was not exposed at this location.





Stop 3: Road cuts along the road exposing the Mariposa Member of the Nogales Formation.

Stop 4 was behind the local Safeway and was of an exposure of a clay unit within the Mariposa Member of the Nogales Formation. This unit is estimated to be greater than 60 meters thick and in some places possibly being an aquitard, a low permeability area within an aquifer. There was a fault within the unit that juxtaposed a more gravely unit within the Mariposa Member with the clay unit.



Stop 4: The group views the clay unit of the Mariposa Member. The fault starts at the top left of the photo (see arrow), passes behind the light pole, and extinguishes in the middle of the photo.

Clay unit on the left, more gravel-rich unit on the right.

Stop 5 was across from the local Pep Boys and was of an exposure of the Nogales Wash Member of the Nogales Formation. This member is the most consolidated and fractured of the three informally defined members of the Nogales Formation. This was the last geology stop of the day.





Stop 5: Ric Page (center) explains the geology of the area, including this road cut of Nogales Wash Member of the Nogales Formation. This unit is exposed next to the Nogales Formation across from the local Pep Boys.

Stop 6 was to the USGS 09480500, a streamgage near the international border that monitors streamflow within the Santa Cruz River. This was an important location to visit because the information collected at the gage (stream stage) is used to estimate discharge of the Santa Cruz River into the SCAMA micro-basins groundwater model. As detailed, the river is the most important constraint on the groundwater model and the discharge, as it flows downstream (in reality) and is routed downstream by the streamflow routing package (in the model) recharging the aquifers, which are then pumped by the Nogales and/or other wells located in the

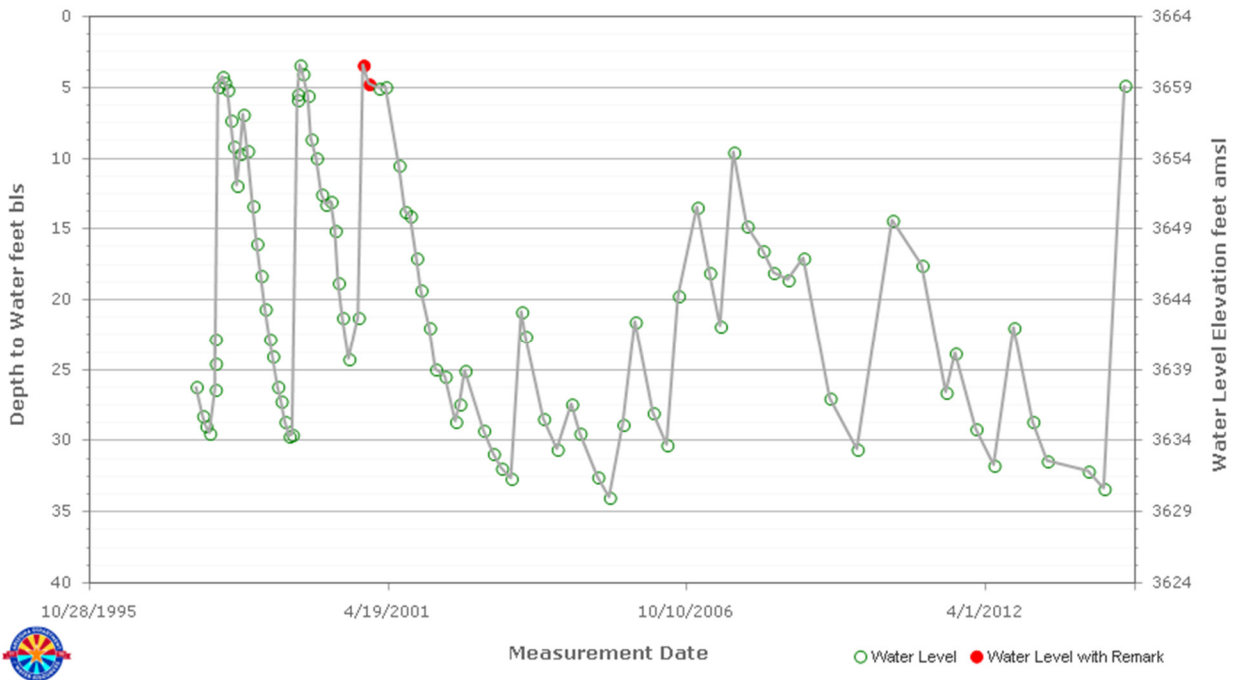
area. ADWR has an index well located just north of the gage, D-24-18BAD UNSURV.



Stop 6: USGS 09480500 near Nogales (off screen, to right) along the Santa Cruz River. This provides an important constraint on the micro-basins groundwater model.

Stop 7 was to ADWR's index well located in Kino Springs, D-24-15 06AAD. This well has a transducer that monitors the water level. This data is collected by the basic data staff for ADWR and entered into ADWR's Groundwater Site Inventory database. This data, which is available to the public, is used as one of the primary targets in the micro-basin groundwater model calibration. It also displays the dependency of the groundwater system on the river, documenting how groundwater levels rise and fall with flood flows, most of which come during the cyclical monsoon season (see hydrograph).





D-24-15 06AAD Hydrograph (as of 4/27/15; <https://gisweb.azwater.gov/gwsi/>)



Stop 7: ADWR index well D-24-15 06AAD. Transducer unit located within white box.

Stop 8 was to the both to the City of Nogales' well pump house and an ADWR index well, D-23-14 36BCB1. This index well provides another important target for the micro-basin groundwater flow model.



Stop 8: ADWR index well D-23-14 36BCB1 as viewed across the river from the Nogales pump house.

Stop 9 was to a spot along the Santa Cruz River named the Guevavi Narrows. This site, located in the Guevavi micro-basin, is important because it is a lateral constriction in the river,



largely controlled by the local geology (Nogales Wash member crops out in this location). Historically, this created conditions where there was perennial baseflow to the Santa Cruz River. However, since about the mid-1960s, baseflow is no longer perennial and has largely been dependent on flood flow following heavy rains, usually during the monsoon. This condition is likely due to groundwater mining.



Stop 9: Guevavi Narrows, with rocks of the Nogales Formation cropping out on the left. This is a narrow, lateral constriction along the river that historically provided conditions for perennial baseflow.

Stop 10 was to Atascosa Ranch where J. David Lowell, ranch owner, led us down into Peck Canyon. Here we walked along an important tributary of the Santa Cruz River that flows

for 3-4 months of the year. There is an important geologic constraint to this tributary, where a major north-northwest striking range-front fault juxtaposes upstream volcanic rocks that discharge baseflow during parts of the year (gaining reach) and downstream gravels where water infiltrates into the subsurface (losing reach). Calibration target data for this area infers a high-K zone that conveys sub-surface flow beneath the stream to the north where it meets up with the Santa Cruz River. This is further described in ADWR Model Report No. 14 as Alternative Conceptual Model #2.



Stop 10: Looking down Peck Canyon. A fault runs across this tributary near the group. Here volcanic rocks are juxtaposed against sands and gravels and hydrologic conditions change the tributary from a gaining to a losing reach.



Stop 11: The final stop of the day was at Sopori Wash. Here there are very shallow water tables to the west but deep depth to water to the east, implying a hydraulic disconnect between the two sides. This could possibly be due to a fault cutting across the wash, similar to Atascosa Ranch. The area to the east is generally in direct hydraulic connection with the inner Santa Cruz Valley.



Stop 11: Looking south across Sopori Wash.